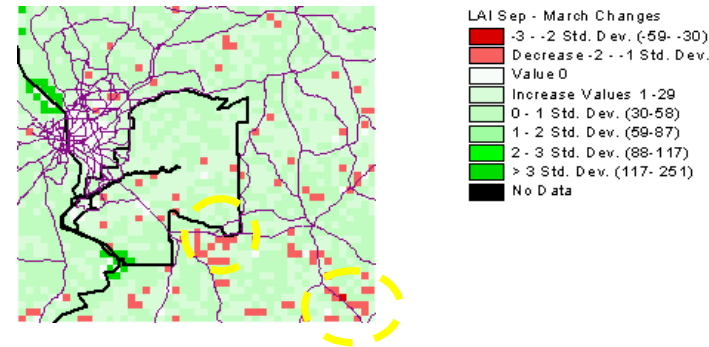
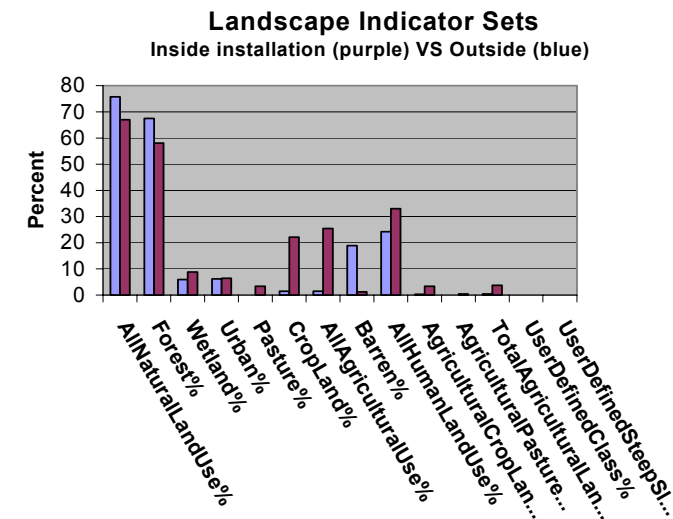


## Red Flagging Encroachment Landscape Change Using Ecological Change Indices

Landscape ecology evaluations are moving toward complex, regional assessments. Packages of landscape multistressor indicators provide the format to make the generation of a suite of quantitative measurements of the environmental condition or vulnerability of an area easier.



**Single Indicator: Leaf Area Index (LAI):** Occurring within 6 months, this change in the NASA MODIS imagery-derived LAI around Fort Benning between March and September of 2001 shows two areas of concern – the linear road widening (lower right) and forest clearing activity (at the southeast corner of the installation).



## Benefits

Encroachment can have significant and permanent implications on opportunities to test and train, but is a decades-long process of change that is easy to overlook in installation planning. ARR-MI allows installation managers and planners to answer the following questions:

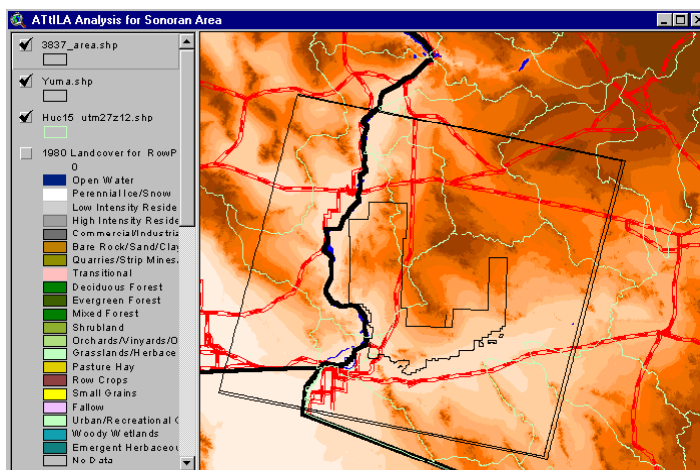
- Which installations are the most at risk from exogenous factors?
- How will land change affect military operations at a given installation?
- Over decades, how is the regional distribution of threatened and endangered species habitat increasing conflicts with military missions?
- What strategic land ownership and land-use changes will improve the military's ability to train in the future?



## US Army Corps of Engineers®

Engineer Research and Development Center  
For more information:

Construction Engineering Research Laboratory  
Phone: 1-800-USA-CERL, ext 6367  
Email: Robert.C.Loazar@erdc.usace.army.mil  
Fort Future: <http://bc.cecer.army.mil/ff/>  
SERM: <http://www.cecer.army.mil/KD/SERM>



A Landscape Health Indicator Package set up for the area around Yuma Proving Ground, AZ provides the format to quickly generate multiple indicators

The following chart shows the output for the Landscape Character set within a package. This is one of four sets of outputs (*Landscape Characteristics, Human Stresses, Riparian Characteristics, and Physical Characteristics*).

by Robert Lozar

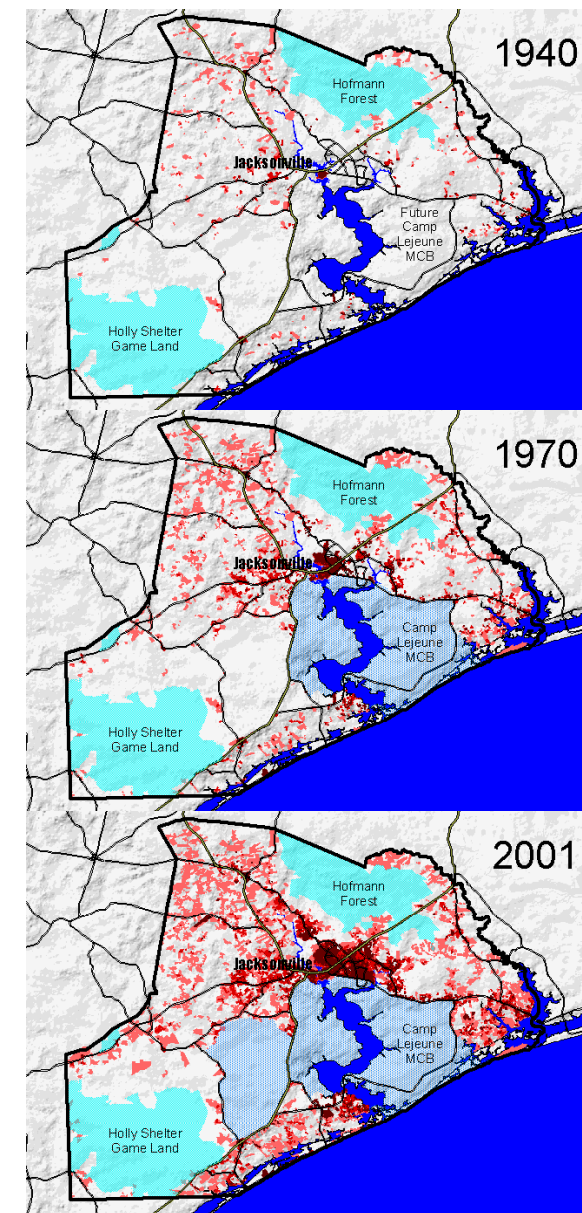
ERDC/CERL TN-03-4

July 2003

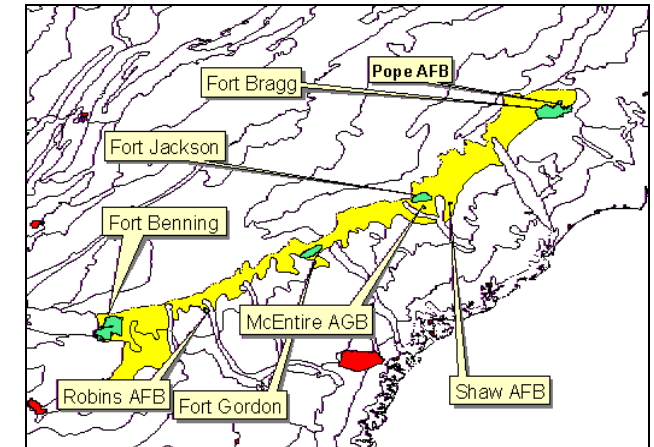
## Analysis of Regional Risks to Military Installations (ARR-MI)

The ARR-MI expertise identifies *regional level* encroachment trends and impacts on military installation missions. ARR-MI:

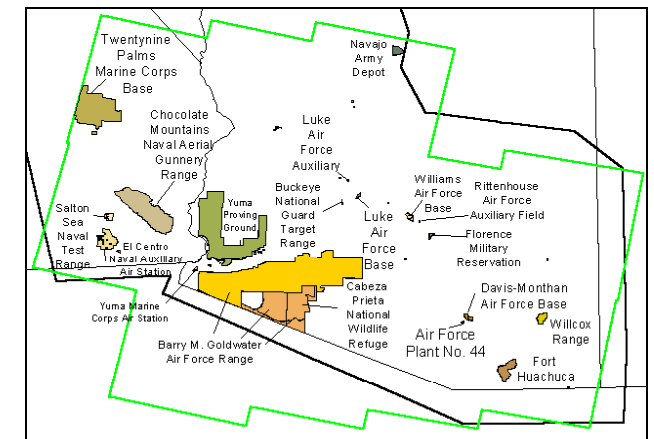
- Results in a time series of the landscape changes over 30 or more years,
- Can be completed for a single installation or an entire region, at varying detail,
- Identifies potential mission encroachment conflicts.



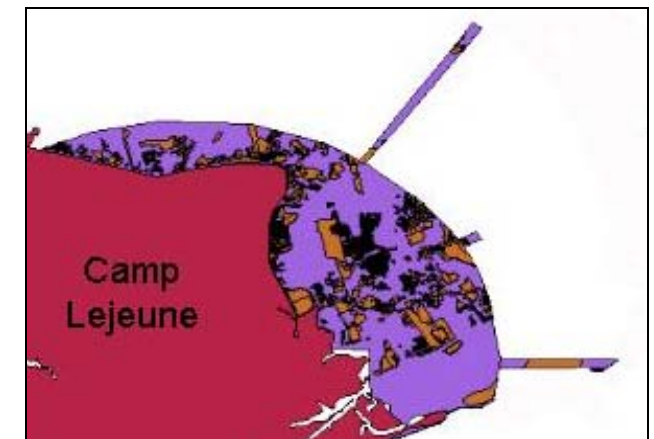
Time series growth near Camp Lejeune, NC



The Sandhills Ecoregion in the southeast includes several military installations



Similarly, the Sonora Ecoregion in the southwest includes a large number of military installations



Off Installation Parcels within Level 1 (purple) Noise Zone.



## Problem

Numerous external pressures are affecting the ability of the military services to maintain force readiness. Encroachment is any outside activity, law, or pressure that affects the ability of military forces to train to doctrinal standards or to perform the mission assigned to the installation. Pressures result from urban growth near installations, noise, legislation protecting habitat, regional fragmentation, airspace use, and stakeholder group issues. Installation managers need tools to identify and monitor encroachment issues, and to determine risks to military training and testing, with an eye to mitigating the risks.

At the same time, pressures to limit training and testing increase from outside the fence line; inside the fence, more installation land area for these activities is required because of changing weapon systems and doctrine. The need for increased training areas is challenging due to:

- Base closure
- Transformation of units and mission
- Difficulty in acquiring more land
- Increasing environmental laws protecting on-post resources.

## Solution

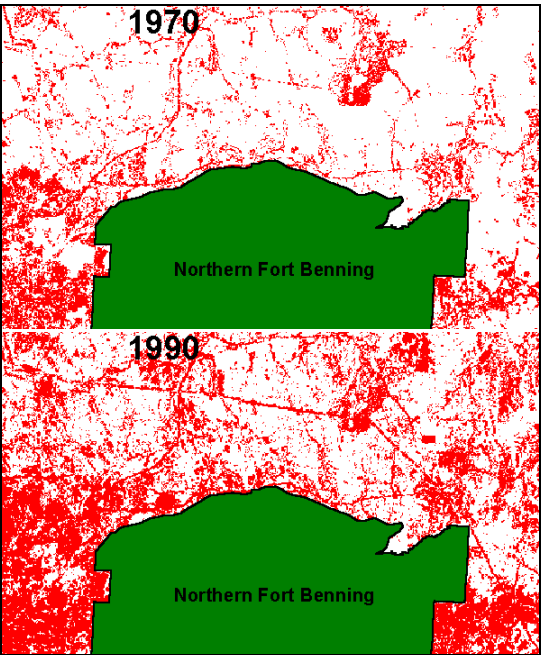
The objective of ARR-MI is to identify regional level encroachment trends and impacts on the military mission of installations. ARR-MI is a component of the Sustainability, Encroachment, and Room to Maneuver (SERM) program. It can provide technologies and data to help installations and units proactively plan to protect the mission sustainability of DoD's current and future capabilities and assets.

**ARR-MI is the Regional (versus local or national) analysis part of Fort Future, a technology suite to help units and installations plan for future requirements.**

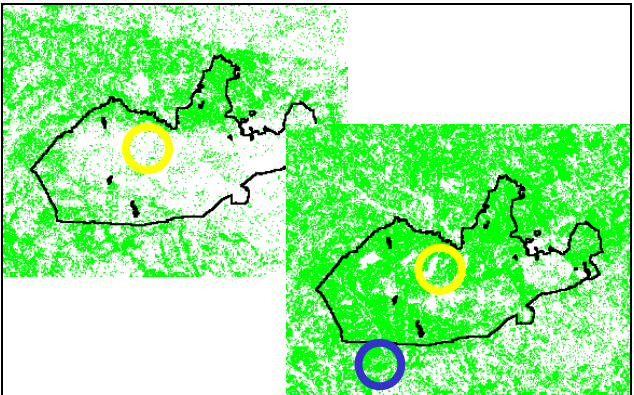
## Expertise and Products

### Conduct Trend Analysis

ARR-MI can collect and portray historic and current trends in risk factors. Trends are drawn from the analysis of historic land use and land cover maps, satellite images, and other sources.



**Red areas show land uses that may potentially conflict with military activities at Fort Benning, GA**

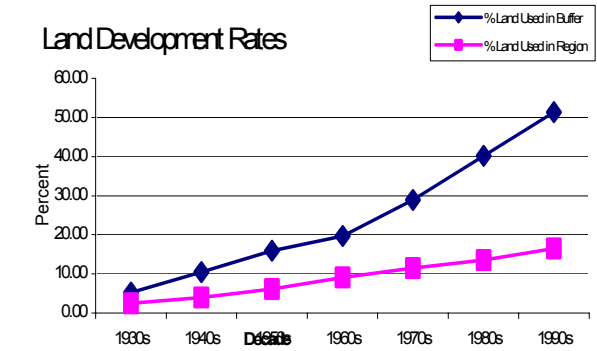


**Trends in forest density surrounding Fort Bragg.**

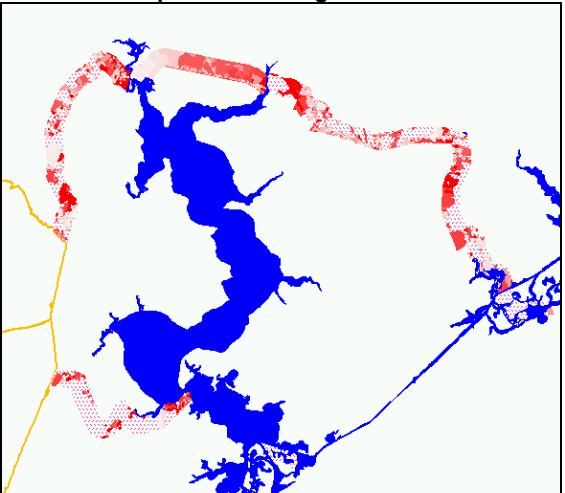
Forested areas that are increasing at a greater than average regional rate are circled in blue; those that are increasing at less than the regional average are circled in yellow.

## Identify Potential Boundary Conflicts

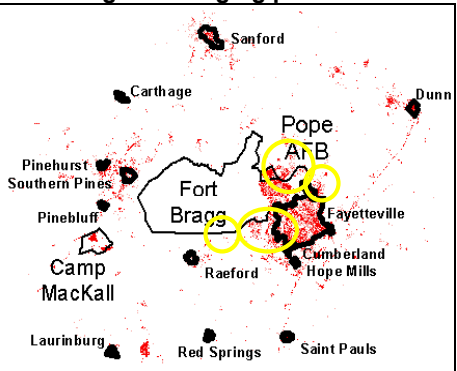
As more of the land adjacent to installations is used for residential and commercial purposes, the likelihood for conflicts increases. Identifying emerging conflicts allows planners to take mitigating proactive actions.



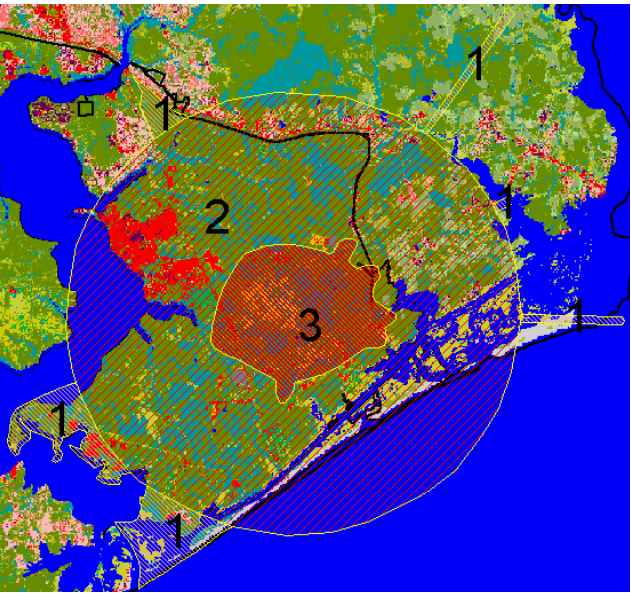
**The rate of land development within 1 kilometer of Camp Lejeune is increasing faster than the regional rate. Knowing the rate substantiates installation staff alarm to headquarters managers.**



**Development within 1 kilometer of Camp Lejeune borders. Redder areas are more recent development. Knowing the locations helps to proactively focus efforts to prevent or mitigate emerging problems.**



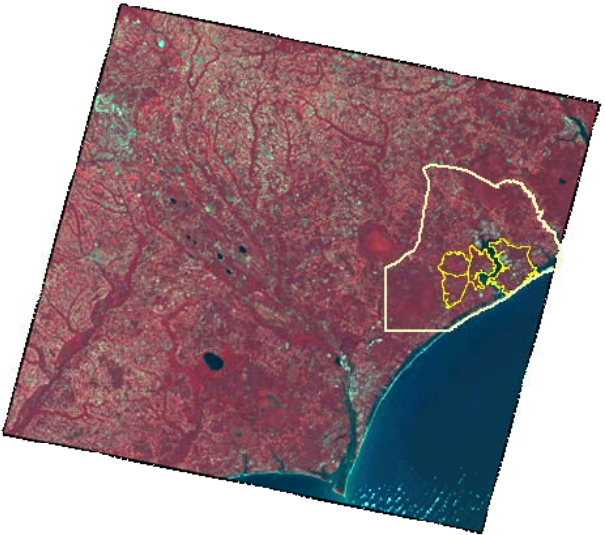
**Land use hot spots near Fort Bragg, NC**



**Noise zones on the eastern side of Camp Lejeune set over land uses**

### Compile GIS and Imagery Data

ARR-MI can use contextual GIS information and datasets from the National Land Cover Data (NLCD) and North American Land Characterization (NALC). The NLCD provides data for the early 1990s and uses standard land cover classes. The NALC data provides imagery for the 1970s, 1980s, and early 1990s in a consistent georeferenced set. Analysis of these images provides an objective evaluation of land cover and landscape ecology trends.



**Example NALC image for the 1980s, including Camp Lejeune (yellow) from which land use is derived.**